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(54) Process for gas-assisted injection moulding and gas injection nozzle for use therein

(57) A gas injection nozzle (15) comprises an elongated nozzle body (151) having a first internal gas channel (156), a nozzle cap (152) having a conical body, the end of the cone tip of which has a thread (159) or a plurality of circular grooves (159') [Fig 2B, not shown] on the exterior surface, the end of the cone base having a receiving recession for receiving the front end of the nozzle body (151). The conical nozzle cap (152) has second and third gas channels (157, 158) connected in series, and the first gas channel (156) of the nozzle body (151) is aligned with the second and third gas channels (157, 158) to constitute a complete gas channel. The diameter of the second gas channel (157) is larger than that of the first and third gas channels (156, 158). A spring (154) is installed inside the second gas channel (157) and has its one end abutting on the internal side wall of the second gas channel (157). A nozzle pin (153) is installed inside the second and third gas channels (157, 158) and is surrounded by the spring (154). The nozzle pin (153) has an elongated pin body with enlarged conical caps at both ends, wherein one of the nozzle caps abuts on one end of the spring, while the other of the nozzle cap extends out of the third gas channel (158) of the nozzle cap (152).

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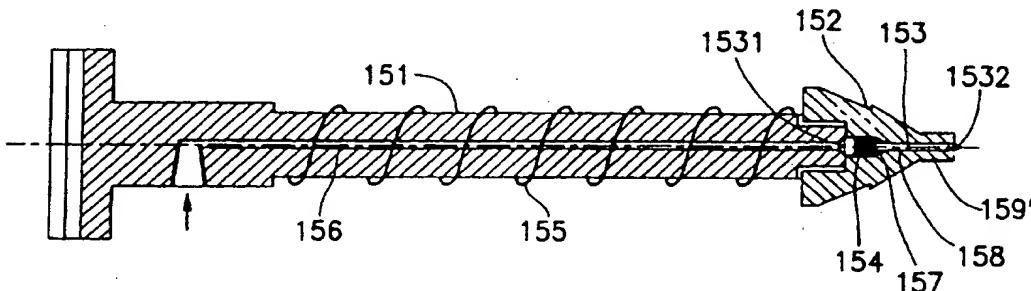


FIG. 2A

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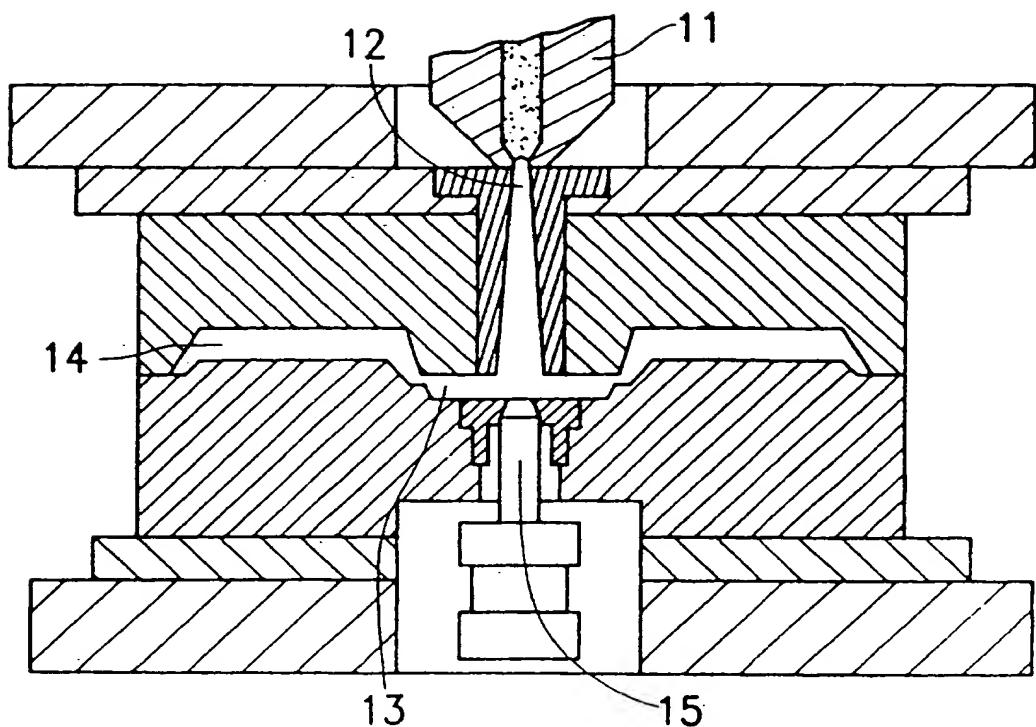


FIG. 1A

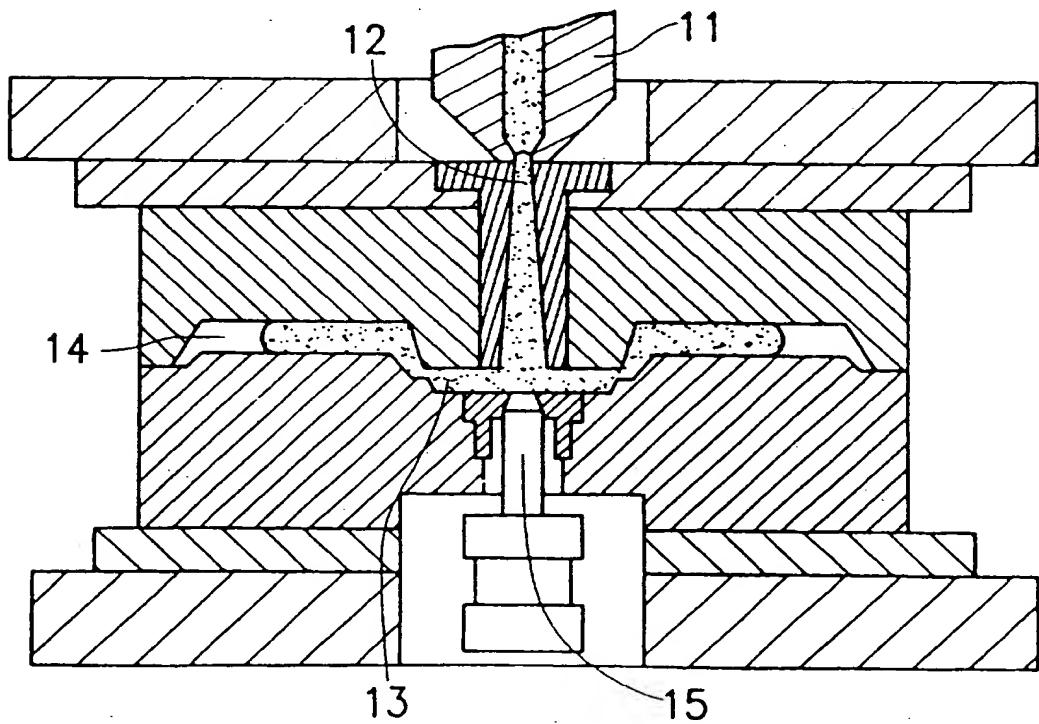


FIG. 1B

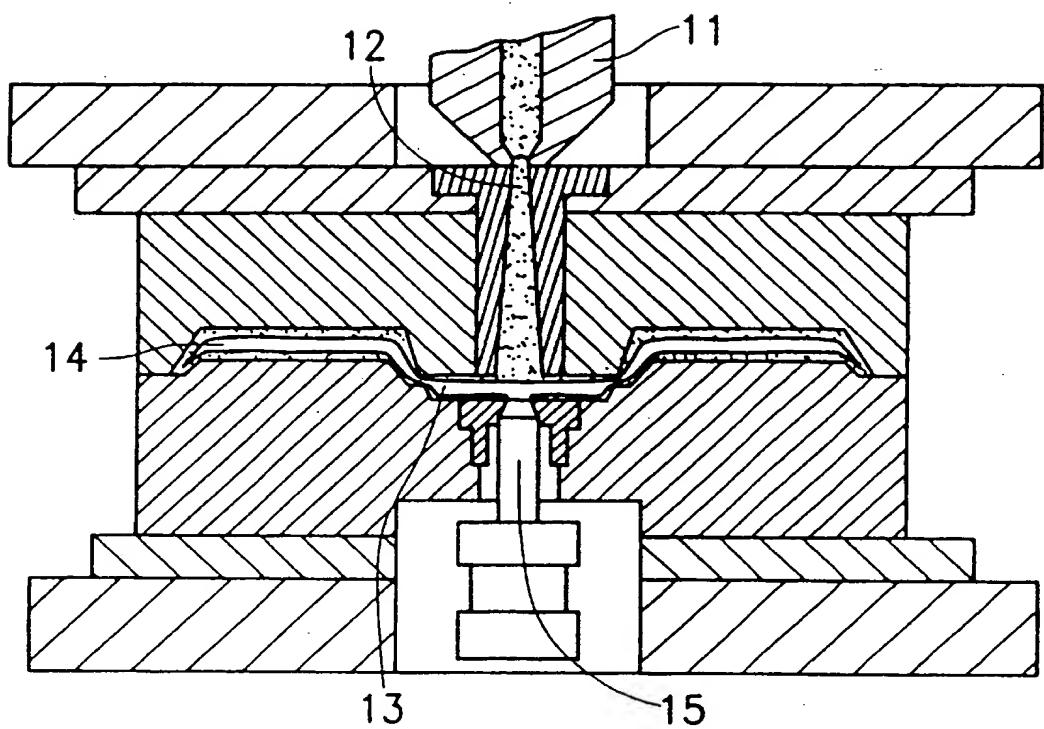


FIG. 1C

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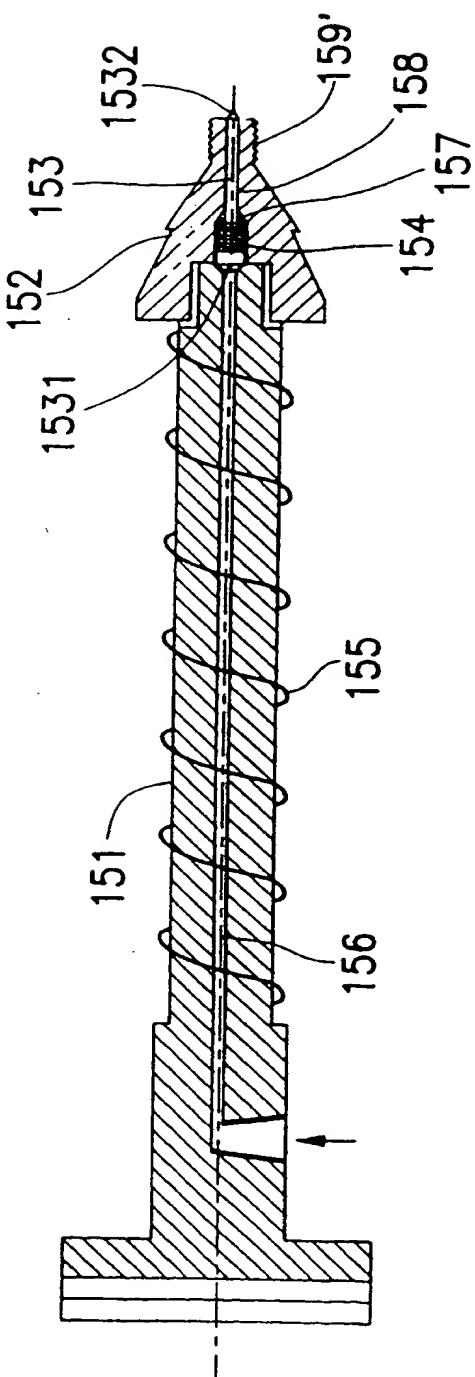


FIG. 2A

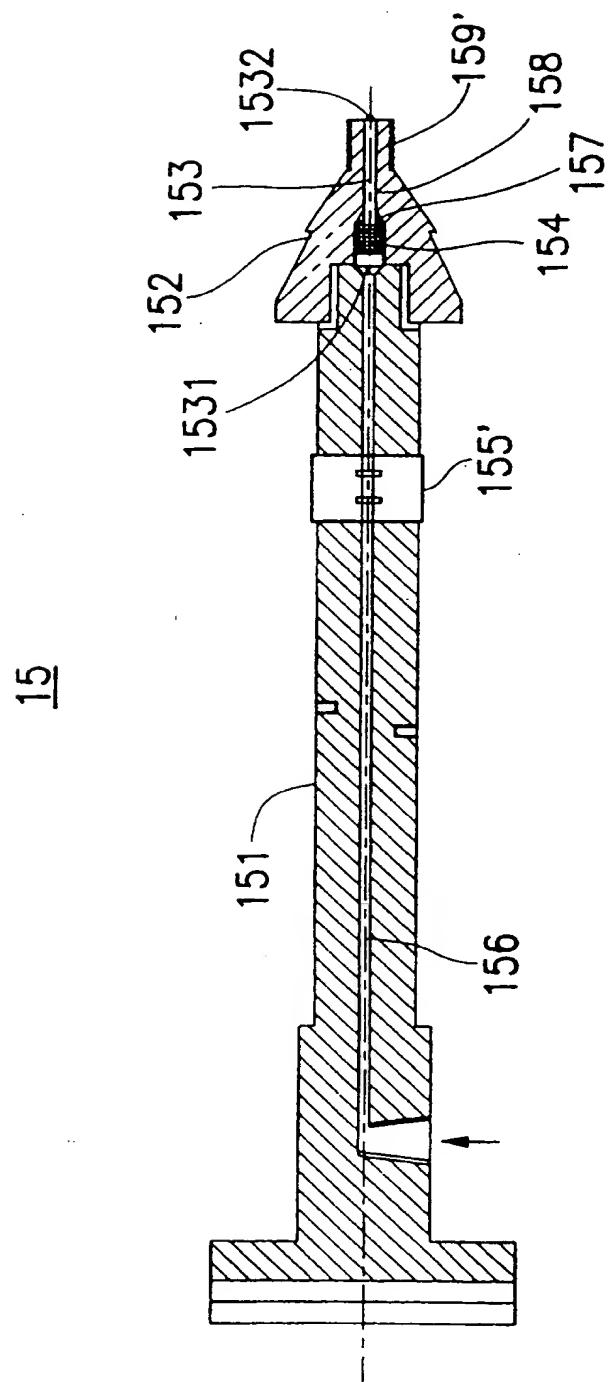


FIG. 2B

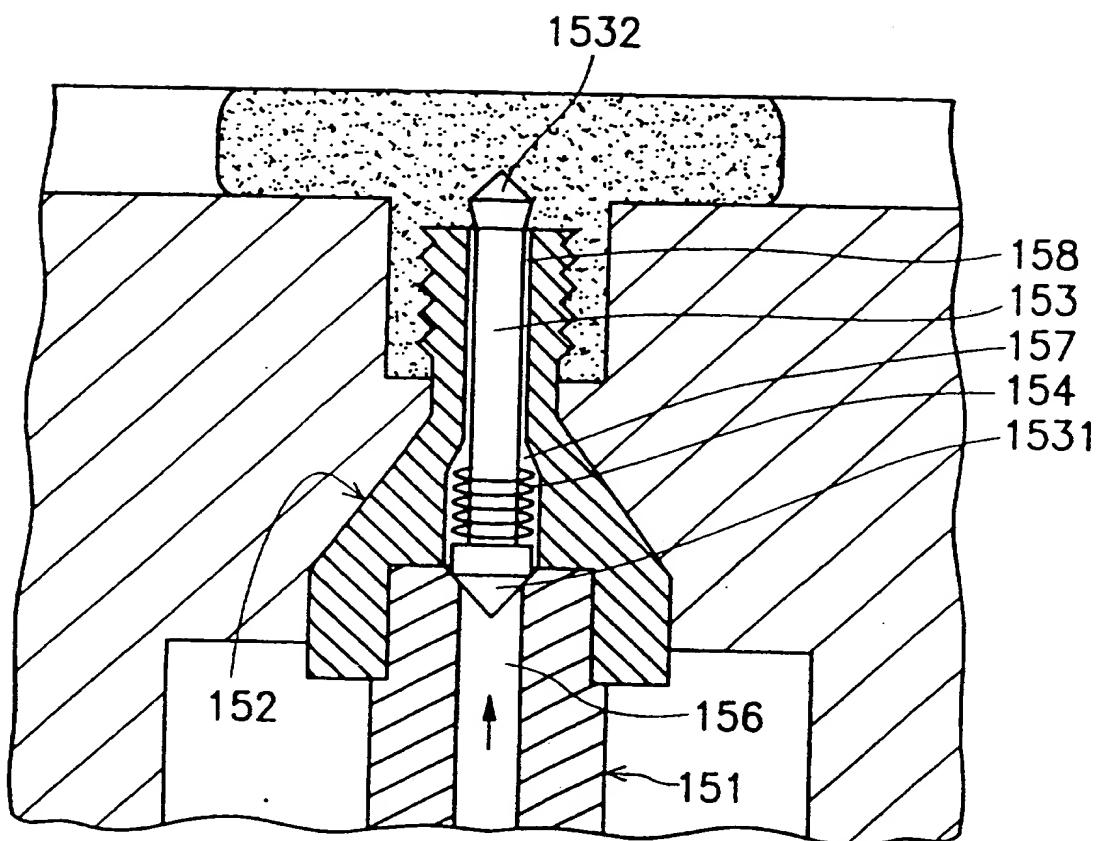


FIG. 3A

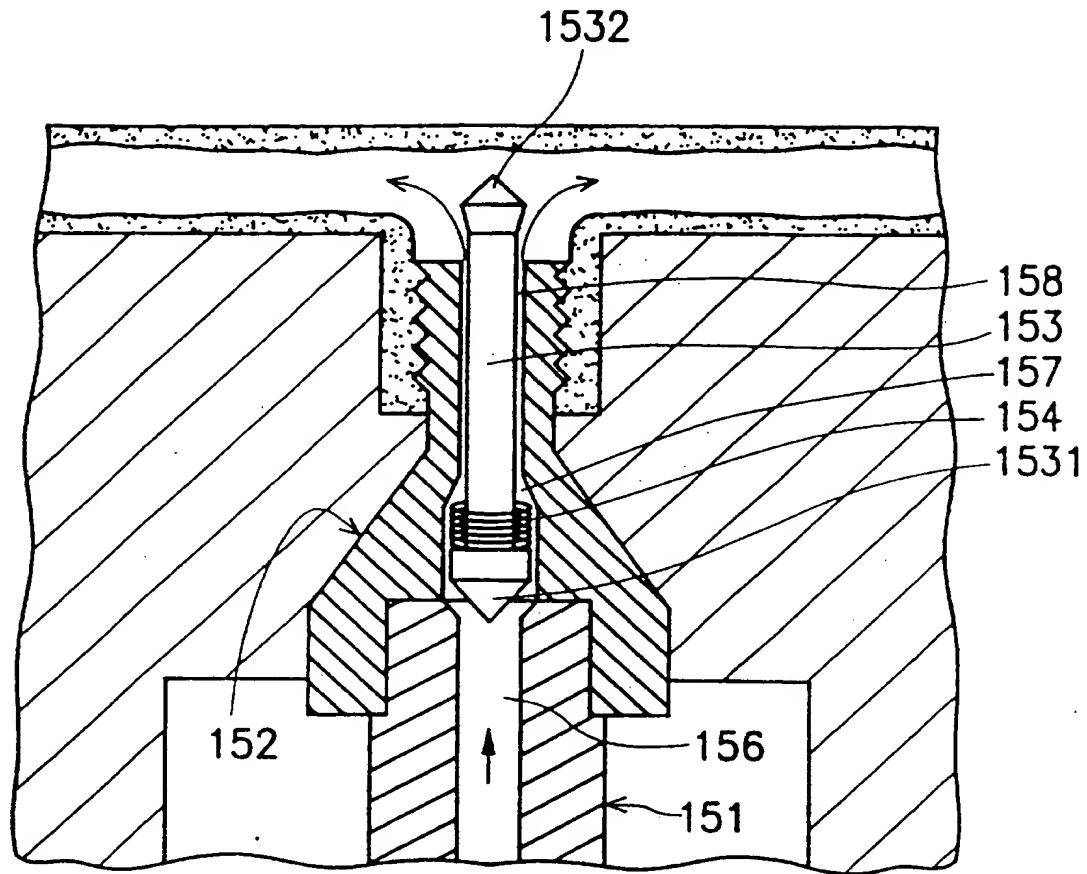


FIG. 3B

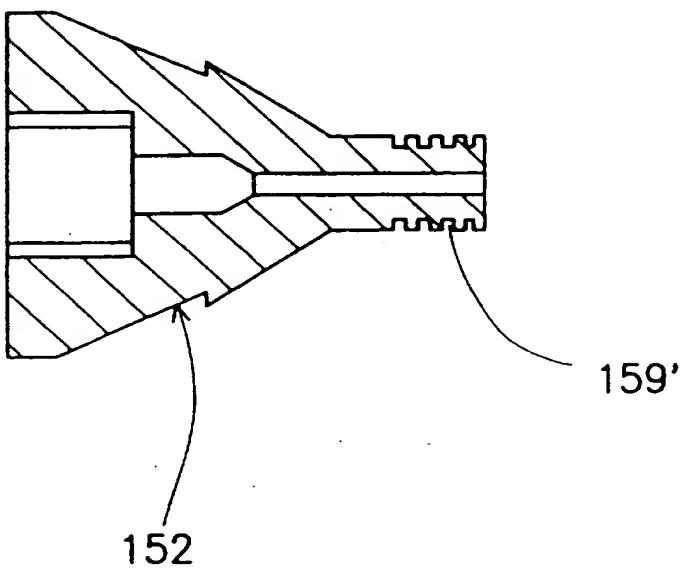


FIG. 4

A GAS INJECTION NOZZLE AND A PROCESS
FOR GAS-ASSISTED INJECTION MOLDING

5 The present invention relates in general to a gas injection nozzle and a process for gas-assisted injection molding. In particular, the present invention relates to a gas injection nozzle for gas-assisted injection molding featuring excellent gas enclosure capability.

10 Gas-assisted injection molding has become an important technique for the art of plastic injection molding. Gas-assisted injection molding has virtually revolutionized the art of plastic injection by providing a method of cost-effective plastic injection molding, as well as reduced injection molding cycle time. The appearance of the plastic component as molded in the gas-assisted injection molding process is improved, resulting in a substantial increase in the product yield rate.

15 To assist in the description of the present invention, a brief review of the process of conventional gas-assisted injection molding is presented in the cross-sectional views FIGS. 1A-1C of an injection mold. FIGS. 1A-1C schematically show the process of a gas-assisted injection molding operation in three cross-sectional views of an injection mold.

20 As is seen in the cross-sectional views of FIGS. 1A-1C, raw material supply nozzle 11 is inserted into the injection mold block. Raw material for the injection molding is supplied via the raw material supply nozzle 11 which gets subsequently into the sprue 12 and the runner 13. The raw material then fills the molding cavity 14, as is seen in FIG. 25
30 1B by the dotted fill-up.

High purity gas such as nitrogen is then injected into the mold via the gas injection nozzle 15. This injected gas assists to force the molten raw material of plastic into

corners where the gas pressure is lower, the temperature is higher, and the viscosity is lower. The pressure-providing gas (such as nitrogen) is continuously injected to maintain pressure inside the mold cavity. This allows for sufficient supply of material to the relatively remote locations inside the sprue 12, as well as to the narrower or thinner portions of the mold, as is seen schematically in FIG. 1C.

Such gas-assisted injection molding technique can avoid the surface sinking phenomena at the portions of the molded component where the thickness is greater. Due to the discrepancies in the thickness at different portions of a molded component inside the mold cavity, the temperature cool down rate is different at these different portions. Since the gas-assisted injection molding technique can achieve more even distribution of the molten raw material inside the mold, the cooling rate in the entire molded component body may be relatively more even, thereby preventing the surface sinking found in conventional plastic molding techniques. There also is even less possibility of insufficient raw material being deployed in the remote and narrow portions of the mold cavity. The gas-assisted injection molding is therefore particularly suitable for molding large plastic components while avoiding twisting, deformation, or insufficient injection of material in the body.

However, this prior art gas-assisted injection molding technique still suffers from the problems caused by the trouble in maintaining the pressure of injected gas inside the mold cavity. This gas leakage phenomena is due to the contraction of the molded plastic component when it is cooled down after the raw material injection procedure is completed. When the molded component contracts, either spaces between the gas nozzle cap and the surface of the molded component, or micro cracks on the surface of the molded component, will be produced to allow for the escape of injected gas inside the mold cavity. Severe gas leakage leads to a poor gas-

assisting effect, when this effect is essential to the gas-assisted injection molding technique, and the problems of degraded product surface appearance, twisting, deformation, and other problems thus reappear.

Efforts have been made to solve this problem of maintaining gas pressure inside the molding cavity. For example, Australian Patent No. 591385, Canadian Patent No. 561436, European Patent No. 0283207, Korean Patent No. 88-2732, British Patent No. 2210578 and U. S. Patent No. 4,740,150 all have disclosed the use of conical gas injection nozzles inserted within the raw material so as to assist in the blowing expansion of the molten material to facilitate the injection molding of the fabricated component. They, however, all fail to maintain gaseous pressure inside the molding cavity when the process of injection molding has concluded and the temperature of the component has cooled down, because they inevitably have gas-leaking spaces formed between the surface of the nozzle cap of the gas injection nozzle and the surface of the injection molded component at the region that comes in contact with the nozzle cap.

It is therefore the primary object of the present invention to provide a gas injection nozzle for the gas-assisted injection molding procedure that maintains gas pressure inside the mold cavity.

The present invention achieves the above-identified objects by providing a gas injection nozzle for gas-assisted injection molding that comprises a nozzle body, a nozzle cap, a spring and a nozzle pin. The elongated nozzle body has a first gas channel internal to the nozzle body. The nozzle cap has a conical body, the end of the cone tip of the nozzle cap has a thread on the exterior surface, and the end of the cone base thereof has a receiving recession for receiving the front end of the nozzle body. The conical nozzle cap has a second and a third gas channel connected in series, and the first gas channel of the nozzle body is aligned with the

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second and third gas channels to constitute a complete gas channel. The diameter of the second gas channel is larger than that of the first and third gas channels. The spring is installed inside the second gas channel and has its one end abutting on the internal side wall of the second gas channel. The nozzle pin is installed inside the second and third gas channels and is surrounded by the spring. The nozzle pin has an elongated pin body with enlarged conical caps at both ends, wherein one of the nozzle caps abuts on one end of the spring, while the other of the nozzle cap extends out of the third gas channel of the nozzle cap.

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Other objects, features, and advantages of the present invention will become apparent by way of the following detailed description of the preferred but non-limiting embodiments. The description is made with reference to the accompanying drawings in which:

FIGS. 1A-1C schematically show the process of a gas-assisted injection molding operation in three cross-sectional views of an injection mold;

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FIGS. 2A-2B show the cross-sectional views of two gas injection nozzles respectively in accordance with the preferred embodiments of the present invention;

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FIGS. 3A-3B show the cross-sectional views of two gas injection nozzles respectively in an injection mold in the process of injection molding; and

FIG. 4 shows the cross-sectional view of the nozzle cap of the gas injection nozzle in accordance with another preferred embodiment of the present invention.

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For a description of the gas injection nozzle of the present invention, reference is directed first to FIGS. 2A and 2B, wherein the cross-sectional views of two gas injection nozzles made respectively in accordance with the preferred embodiments of the present invention are shown.

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As seen in the drawing, the preferred embodiments of the gas injection nozzle 15 of the present invention are

shown to include a gas nozzle body 151, a gas nozzle cap 152, and a gas nozzle pin 153 together with its corresponding spring 154.

The nozzle body 151 is substantially an elongated rod, having wound on the longitudinal body thereof a heating coil 155 in the first embodiment of FIG. 2A, or attached on the longitudinal body thereof a heating plate 155' in the second embodiment of FIG. 2B. Internal to the nozzle body 151 of both the first and second embodiments, there is provided a first gas channel 156 running internal to the longitudinal body thereof.

The nozzle cap 152 is substantially a conic-shaped body, with its base end connected to the corresponding front end of the nozzle body 151. The connection may be implemented by, for example, the recession formed at the conical base of the nozzle cap 152 that receives the insertion end of the nozzle body 151 having a reduced diameter, as shown in the cross-sectional view of FIG. 2A. Along the center axis of the conical cap 152 there is provided a second gas channel 157 of the entire gas injection nozzle that is connected to a third gas channel 158 also formed along the center axis of the cap 152. The diameter of the second gas channel 157 is larger than that of the third channel 158, so as to incorporate a coil spring 154. When the nozzle cap 152 is attached to the front end of the nozzle body 151, the first gas channel 156 inside the nozzle body 151 will be aligned with the second gas channel 157 of the nozzle cap 152. This establishes a complete gas channel in both the nozzle body 151 and the nozzle cap 152 that includes the first, second and third gas channels 156, 157 and 158 respectively.

The end of the conical tip of the nozzle cap 152 converts substantially into a short cylinder of small diameter, having a thread 159 formed on the exterior surface thereof, with the center axis of the helical thread

coinciding with the center axis of the nozzle cap 152. The thread 159 has a length of about 50-150 mm, and is recessed into the surface of the cylindrical body thereof to a depth of about 0.2-0.5 mm.

5 Structural details of the nozzle pin 153 may best be observed in the cross-sectional views of FIGS. 3A and 3B. The gas nozzle pin 153 is substantially a length of rod having conical tips 1531 and 1532 at each of its ends respectively. The diameter of the conical tip 1531 is larger
10 than that of 1532 so as to have a base that provides a flange for the helical spring 154 to rest its one end when the nozzle pin 153 is installed within the second and third gas channels 157 and 158 inside the nozzle cap 152. The nozzle pin 152 will be inserted into the cylindrical space surrounded by the helical spring 154, and, as is already described above, the one end of the spring 154 rests on the flange of the base of the conical end 1531, while the other end thereof abuts on the shrinking interconnecting section between the two gas channels gas channels 157 and 158, as is
15 shown in FIG. 3A.
20

While the major section of the nozzle pin 153 having the conical cap 1532 is inserted inside the third gas channel 158, there is still sufficient space between the surface of the nozzle pin 153 and the inner side wall of the third gas channel 158 that allows the gas to flow therethrough. On the other hand, if required, the surface of the conical cap 1531 at one end of the nozzle pin 153 may rest on the corresponding conical opening of the first gas channel 156 inside the nozzle body 151 to block the gas flow, although
25 the spring 154 may be subjected to compression to allow for the passage of gas in the connected gas channels when necessary.
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During the use of the gas injection nozzle of the present invention in the gas-assisted injection molding process, the molten raw material for the injection molding
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operation is injected into the molding cavity via the sprue, as is shown in FIG. 3A. When the internal space of the molding cavity is filled up to about 70-90% of the entire volume, the gas injection nozzle is immediately inserted in the sprue or in the runner. As is seen in FIG. 3A, the injection gas (such as nitrogen) flows in the first gas channel 156 inside the nozzle body 151 in the direction as is shown by the arrow. With sufficient pressure, the conical cap 1531 of the nozzle pin 153 is pushed upward (in the direction relative to the orientation of FIG. 3B) while the spring 154 is compressed by the gas pressure. In this instance, conical cap 1532 at the other end of the nozzle pin 153 is also pushed upwardly to open up a passage for the gas to enter into the space inside the molding cavity.

Thus, the gas supply not shown in the drawing will be able to blow gas through the first gas channel 156 in the nozzle body 151, and subsequently via the second and third gas channels 157 and 158 in the gas nozzle cap 152, into the gas channel inside the molding cavity. This flow of gas may serve to facilitate the movement of the molten raw material in the cavity toward the regions of lower gaseous pressure, higher temperature, and lower viscosity.

The gas is kept flowing into the molding cavity while the heating coil or plate (155 of FIG. 2A or 155' of FIG. 2B) maintains the temperature of the gas nozzle body 151 and the gas nozzle cap 152 at about 60-100 degrees Celsius. The thread 159 formed over the exterior surface of the tip cylinder of the gas nozzle cap 152 serves to increase the contact surface area between the surface of the molded plastic material and the gas nozzle cap 152. This curvature contact surface also provides an effect similar to that of an O-ring withholding to the molded plastic material. The tight and leakage-proof contact between the surface of the gas nozzle cap 152 and the molded plastic material is therefore secured. No gas leakage is therefore possible between the

interfacing area of the gas nozzle cap 152 and the molded material, since there is barely any space in between. Good gaseous pressure conservation is therefore possible. When the gas pressure provision is removed, the spring 154 will 5 push the gas nozzle pin 154 downward toward the gas nozzle body 151, as is seen in FIG. 3A. This closes the first gas channel 156 behind the molding cavity, thereby preventing the gas flow reversal.

FIG. 4 shows the cross-sectional view of the nozzle cap 10 152 of the gas injection nozzle 151 in accordance with another preferred embodiment of the present invention. In this exemplified embodiment, concentric circular grooves 159' serve the same function of the thread 159 in the embodiment of FIG. 3A and 3B, namely, to provide for the increase of the contact surface area between the surface of the conical gas 15 nozzle cap 152 and the molded plastic material.

Thus, the gas injection nozzle of the present invention as described in the preferred embodiments feature the improved operating characteristics by preventing the gas 20 leakage problem. An injection molding process without the constant gas leakage that plagues the conventional gas-assisted injection molding procedures clearly reduces operating costs.

As persons skilled in this art may well appreciate, the 25 above description of the preferred embodiments of the present invention is employed for the purposes of description, not to restrict the scope of the present invention. Modifications to the outlined embodiments of the present invention may be apparent and should be considered to be within the scope of 30 the present invention that is recited in the claims that follow.

CLAIMS

1. A gas injection nozzle for gas-assisted injection molding comprising:

5 an elongated nozzle body having a first gas channel internal to said nozzle body;

a nozzle cap having a conical body, the end of the cone tip of said nozzle cap having formed thereon a thread means, and the end of the cone base of said nozzle cap having formed 10 therein a receiving recession for receiving the front end of said nozzle body, said conical nozzle cap having formed therein a second and a third gas channel connected in series, and said first gas channel of said nozzle body being aligned 15 with the second and third gas channels to constitute a complete gas channel for said gas injection nozzle, wherein the diameter of said second gas channel is larger than that of said first and third gas channels;

20 a spring installed inside said second gas channel and having one end thereof abutting on the internal side wall of said second gas channel; and

25 a nozzle pin installed inside said second and third gas channels and surrounded by said spring, said nozzle pin having an elongated pin body with enlarged conical caps at both ends thereof, wherein one of said nozzle caps abuts on one end of said spring, while the other of said nozzle cap extends out of said third gas channel of said nozzle cap.

30 2. A gas injection nozzle for gas-assisted injection molding as claimed in claim 1, wherein said thread means has a length of about 50 to 150 mm and a recessed depth of about 0.2 to 0.5 mm.

3. A gas injection nozzle for gas-assisted injection molding comprising:

an elongated nozzle body having a first gas channel internal to said nozzle body;

5 a nozzle cap having a conical body, the end of the cone tip of said nozzle cap having formed thereon a plurality of concentric circular grooves, and the end of the cone base of said nozzle cap having formed therein a receiving recession for receiving the front end of said nozzle body, said conical nozzle cap having formed therein a second and a third gas channel connected in series, and said first gas channel of
10 said nozzle body being aligned with the second and third gas channels to constitute a complete gas channel for said gas injection nozzle, wherein the diameter of said second gas channel is larger than that of said first and third gas channels;

15 a spring installed inside said second gas channel and having one end thereof abutting on the internal side wall of said second gas channel; and

20 a nozzle pin installed inside said second and third gas channels and surrounded by said spring, said nozzle pin having an elongated pin body with enlarged conical caps at both ends thereof, wherein one of said nozzle caps abuts on one end of said spring, while the other of said nozzle cap extends out of said third gas channel of said nozzle cap.

25 4. A gas injection nozzle for gas-assisted injection molding as claimed in claim 3, wherein said grooves have a length of about 50 to 150 mm and a recessed depth of about 0.2 to 0.5 mm.

30 5. A gas injection nozzle for gas-assisted injection molding as claimed in any one of the preceding claims, wherein said nozzle pin is slidably received in said second and third gas channels of said nozzle cap and has a sufficient space between the surface of said nozzle pin and

the inner side wall of said third gas channel for allowing gas to flow therethrough.

6. A gas injection nozzle for gas-assisted injection molding as claimed in any one of the preceding claims, wherein said nozzle body further has a helical heating coil wound around said elongated body.

7. A gas injection nozzle for gas-assisted injection molding as claimed in any one of the preceding claims, wherein said nozzle body further has a heating plate attached to said elongated body.

8. A gas injection nozzle for gas-assisted injection molding substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

9. A process for gas-assisted injection molding, comprising:

(1) injecting molten raw material into a molding cavity provided with a sprue and a plurality of runners;

(2) providing a gas injection nozzle having a nozzle cap with a thread means or a plurality circular grooves formed thereon;

(3) inserting the gas injection nozzle in the sprue or in the runner;

(4) blowing gas into the molding cavity via the gas injection nozzle for pushing the molten raw material to fill the molding cavity; and

(5) cooling the molding cavity and retaining pressure in the molding cavity.

10. A process for gas-assisted injection molding as claimed in claim 9, wherein the thread means or the circular

grooves formed on the nozzle cap have a length of about 50 to 150 mm and a recessed depth of about 0.2 to 0.5 mm.

11. A process for gas-assisted injection molding
5 as claimed in claim 9, wherein the gas blown into the molding cavity is nitrogen.

12. A process for gas-assisted injection molding as claimed in any one of claims 9-11, wherein the step
10 (5) further comprises keeping the temperature of the nozzle cap at about 60-90 degrees Celsius.

13. A gas injection nozzle for gas-assisted injection molding substantially as hereinbefore described
15 with reference to Figures 2 to 4 of the accompanying drawings.

14. A process of gas-assisted injection molding substantially as hereinbefore described with reference
20 to Figures 2 to 4 of the accompanying drawings.



The
Patent
Office

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Claims searched: 1-8, 13 & 14

Examiner: J P Leighton
Date of search: 23 November 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.N): B5A(AD24, AD28, AT14G, AT14P)

Int CI (Ed.6): B29C(45/17)

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO 93/23228 A1 Cinpres Limited - see Figs. 2-4	
A	US 5222514 A Krauss Maffei A.G.- see Figs. 2 & 3	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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